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Geotechnical Issues of Adaption of Eurocode to Kazakhstan Norms



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ABSTRACT: Development of high-rise buildings and constructions in complex hydro-geological condition of some regions of Kazakhstan requires reliable design of foundations, this leads to improvement of the geotechnical national Codes. Unfortunately, present Codes are confined application of modern technology. Aforementioned demands to using international Code, moreover, for realization unique project is required using leading foreign high-tech, economic, ecological and energy-efficient technology, including technology for pile installation, equipment for geological investigation, as well as laboratory testing. Eurocode 7 includes recommendations and requirements for modern advanced technologies and embraced many aspects of modern geoengineering design. This comparison will be basement for future modernization of Kazakhstan codes.

1 INTRODUCTION

Nowadays many international projects are realized in Kazakhstan. For example Italian and American companies which are work on western part of Kazakhstan met some complexity in non correspondences of Kazakhstan codes to international. Kazakhstan engineers also feel some complexity during design modern projects where generally used advanced technologies.

Unfortunately, present Codes are confined application of modern technology of pile foundation installation, indicating incomplete usage of advanced technology such as CFA (continuous flight auger), DDS (drilling displacement system) or FDP (full displacement pile), Jet-grouting DMM (Deep mixing method) technologies and so on.

Aforementioned demands to using international Code, moreover, for realization unique project is required using leading foreign high-tech, economic, ecological and energy-efficient technology, including technology for pile installation, equipment

for geological investigation, as well as laboratory testing.

Eurocode 7 – Geotechnical Engineering which was established in 2004 seems to be more reliable for adaptation for Kazakhstan construction condition. Many countries successfully accepted Eurocode 7 and during last years this Code becoming more international. Eurocode 7 is already show itself as very elaborate design code where given recommendations and requirements for most part of geoengineering process. It also allows using common international geoengineering terms and provides understanding between for designers, testing specialists, geotechnical engineers all over the World. Eurocode 7 include recommendations and requirements for modern advanced technologies and embraced many aspects of modern geoengineering design.

The results of research is directed to developing of recommendation for modernization of Kazakhstan Codes and oriented to adaptation of advanced geotechnologies. The modernization will allow to complete use of advanced technologies capabilities

in existing construction condition of Kazakhstan. It also allows greatly reduce the expenses of the null cycle, which forming significant part (20%) of the total construction project expense.

Development of recommendation for modernization of national geotechnical codes, oriented on adaption of advanced geotechnologies for piles installations in problematical soil conditions of Kazakhstan is very important for designers, testing specialists, geotechnical engineers as long as Codes of many countries has some differences due to of specific regional soil condition, and local specifications. Developing recommendation will be first stride for Kazakhstan construction to be of international part, to be understandable by world Geotechnics. We also believe that this recommendation will be basement for future modernization of Kazakhstan codes

1.1 Introduction to Eurocode 7

The development of Eurocode 7 has been strongly linked to the development of EN 1990: Eurocode: Basis of structural design (CEN, 2002) and the format for verifying ground-structure interaction problems is, of course common to both documents.

After giving the main contents of Eurocode 7, this contribution summarises the requirements relevant to pile design (without recalling the principles of LSD and of the partial factor method).

Design examples of piles under vertical compressive loadings can be found, for instance, in the proceedings of the workshop of ERTC 10 on the evaluation of Eurocode 7

General rules is a rather general documents giving only the principles for geotechnical design inside the general framework of LSD. These principles are relevant to the calculation of the geotechnical actions on the structural elements in contact with the ground (footings, piles, basement walls), as well as to the deformations and resistances of the ground submitted to the actions from the structures. Some detailed design rules or calculation models, i.e. precise formulae or charts are only given in informative Annexes.

The Section on field tests in soil and rock includes cone and piezocone penetration tests CPT (U), Pressuremeter test PMT, flexible dilatometer test (rock and soil) FDT, cone penetration test SPT, dynamic probing tests DP, weight sounding test WST, field vane test FVT, flat dilatometer test DMT and plate loading test PLT.

The Section on laboratory testing of soils and rocks deals with the preparation of soil and rock specimens for testing, tests for classification, identification and description of soil, chemical testing of soil and groundwater, strength index testing of

soil, compressibility and deformation testing of soil, compaction testing of soil, permeability testing of soil, strength testing of soil, compressibility and deformation testing of soil, tests for classification of rocks, swelling testing of rock material and strength testing of rock material.

It also includes a number of informative Annexes with examples of correlations and derivations of values of geotechnical parameters from field test results. The informative Annexes D.6 & D.7 for CPT tests, and E.3, for PMT tests, are such examples for determining the compressive resistance of a single pile.

The core of Section 7 of EN 1997-1 is devoted to the behavior of pile foundations under axial (vertical) loads. The importance of static load tests is clearly recognized as the basis of pile design methods. An innovative concept introduced in this section, with regard to traditional pile design, is the use of correlation factors ξ for deriving the characteristic compressive and tensile resistances, of piles either from static pile load tests or from ground test results. In both cases, the correlation factors ξ depends mainly on the number of tests performed, whether pile load tests or profiles of ground tests.

2 COMPARISON OF EUROCODE WITH KAZAKHSTAN CODES

Nowadays is put into action recommendation of Eurocode 1-8 which are replacing National Codes. However some Countries are transforming it's National Codes by taking into account Eurocode recommendation. For example Japan input some changes into ISO and as a result new published ISO 23469 is a copy of Eurocode 8.

The principal difference between Eurocode and Kazakhstan Code (SNiP RK) is absence of requirements for the geotechnical design in Kazakhstan Codes. In Eurocode the strategy of geotechnical design includes interaction of two researches – geological engineering and geotechnical. However today is difficult to design without qualitative geotechnical investigation. Geotechnical research include results of engineering and geological investigation which are had been used during definition of soil and foundation modeling. Recommendation of Eurocode promote to mutual researchers and designers work. Unfortunately in Kazakhstan practice engineering and geological investigation is one different part of the design, and frequently no interaction between researchers and designers. The program of the geological investigation rarely coordinate to designer and as a result there are absent common strategy of the design.

One another difference of Eurocode is design procedure. According to Kazakhstan Code the design of soil basement is recommended to carry out by three steps. During the first and second step of foundation design it is allowable to use preliminary strengthen and deformative properties of soil taken from table of SNiP RK, during the last third step it is required to perform both laboratory and field test to approve design project. According to Eurocode for all of this three engineering and geological investigation steps for definition strengthen and deformative properties of soil is required to use results of laboratory or field tests only. Moreover Eurocode use term «derive value» that mean value of geotechnical parameter of soil obtained by results of identical laboratory or field test of soil by using correlation relationship or using inverse calculation. For example deformation Modulus obtained by independence tests: laboratory tests, field tests by dilatometer, by correlation relationship with physical parameter, by results of well known settlement calculation (Boldyrev et al. 2010).

Laboratory tests which recommended by Eurocode are presented in Table 1. It is well known that the obtained by laboratory tests mechanical and physical properties of soil depends on quality of soil sample. Eurocode differ five categories of soil samples quality assuming that the properties of soil invariable due to sampling, packing and transportation.

According to Eurocode swelling of soil research for rock soil, whereas according to Kazakhstan Codes concern to unstable structure.

Comparison of national Codes with Eurocode (Boldyrev et al. 2010) shown that there are not yet developed recommendation for performing following field tests:

- Cone penetration test with analysis of pore water pressure (CPTU).
- Cone penetration test by dynamic load (SPT).
- Dilatometer test.

However in Eurocode is absent some recommendation for field tests in condition of frozen soil (Boldyrev et al. 2010).

Modern megaprojects put forward modern requirements to engineers. This led to refuse from traditional out-of-dates technologies (traditional boring and driving diesel-hammer piles) and use new more economical and reliable technologies like CFA (continuous flight auger), DDS (drilling displacement system), steel “H” piles.

Table 1. Eurocode soil laboratory methods

Parameter	Type of soil		
	Gravel	Sand	Sandy

loam			
Compression deformation Modulus (E_{oed})	OED, TX	OED, TX	OED, TX
Compression index (c_c)			
Elastic Modulus (E)	TX	TX	TX
Shear Modulus (G)			
Consolidated Drained strength parameters (ϕ, c)	TX, SB	TX, SB	TX, SB
Residual strength (ϕ_R, c_R)	RS, SB	RS, SB	RS, SB
Undrained strength, (c_u)	-	-	TX, DSS, SIT
Density of soil (ρ)	BDD	BDD	BDD
Consolidation (c_v)	-	-	OED, TX
Filtration	TXCH, PSA	TXCH, PSA	PTS, TXCH, PTF
Parameter	Type of soil		
	NC clay	OC clay	Silt
Compression deformation Modulus (E_{oed})	OED, TX	OED, TX	OED, TX
Compression index (c_c)			
Elastic Modulus (E)	TX	TX	TX
Shear Modulus (G)			
Consolidated Drained strength parameters (ϕ, c)	TX, SB	TX, SB	TX, SB
Residual strength (ϕ_R, c_R)	RS, SB	RS, SB	RS, SB
Undrained strength, (c_u)	TX, DSS, SB, SIT	TX, DSS, SB, SIT	TX, DSS, SB, SIT
Density of soil (ρ)	BDD	BDD	BDD
Consolidation (c_v)	-	-	OED, TX
Filtration	TXCH, PTF, OED	TXCH, PTF, OED	TXCH, PTF, OED

Another advantage of Eurocode is recommendation for design and calculation of modern pile technologies such as CFA, FDP and so on.

Kazakhstan Code has not some recommendation for these piles technology, and so designers have to use recommendation for traditional out-of-dates pile technologies (traditional boring and driving diesel-hammer piles). As a result incomplete usage of modern technology has a place. Design of modern pile by Kazakhstan Code is not include many technologies factors such as high value of concrete pressure during CFA pile installation and soil displacement without excavation during DDS pile installation.

Comparison of safety factors recommended by Kazakhstan Code and Eurocode is presented in Table 2. In this table are listed design safety factor, safety factor for static load test, and safety factor for dynamic load test, together with the number of tests required or specified for a pile construction site.

Table 2. Safety factor of pile tests comparison

Code	Safety factor		Number of test required
	Design	SLT DLT	
Eurocode		2.18	If number of tests equal or less than 2
		1.91	If number of tests equal or greater than 20
		2.23	If 2 DLTs is performed
		1.95	If number of DLTs greater than 20
Kazakhstan Code	1.5	1.4	SLTs on 0.5% of constructed piles on construction site (2 SLTs at least in a site)
		1.2	At least 6 DLTs in a site (or 1% of working piles on construction site)

CONCLUSION

Eurocode 7 – Geotechnical Engineering which was established in 2004 seems to be more reliable

for adaptation for Kazakhstan construction condition. Many countries successfully accepted Eurocode 7. Eurocode 7 is already show itself as very elaborates design code where given recommendations and requirements for most part of geoengineering process. It also allows using common international geoengineering terms and provides understanding between for designers, testing specialists, geotechnical engineers all over the World. Eurocode 7 includes recommendations and requirements for modern advanced technologies and embraced many aspects of modern geoengineering design.

By result of Kazakhstan Code comparison with Eurocode it is become obvious one disadvantage of Kazakhstan Code is absence of recommendation for design, testing and calculation modern pile technologies such as CFA, DDS and so on. Eurocode is also presented by unified documentation for geoengineering comparing with Kazakhstan Code, where many Codes are and where someone may contradict to other.

Comparison also shown that in Kazakhstan Codes is not developed recommendation for performing following field tests: cone penetration test with analysis of pore water pressure, cone penetration test by dynamic load and dilatometer tests.

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